RENEWABLE ENERGY

What is Bioenergy?

Biomass energy, or bioenergy, refers to all forms of renewable energy that are derived from plant materials produced by photosynthesis. Biomass fuels can be derived from wood, agricultural crops and other organic residues. These fuels can be obtained from many sources in Canada, including sawmills, woodworking shops, forest operations and farms.

Case Study

Biomass Combustion Systems

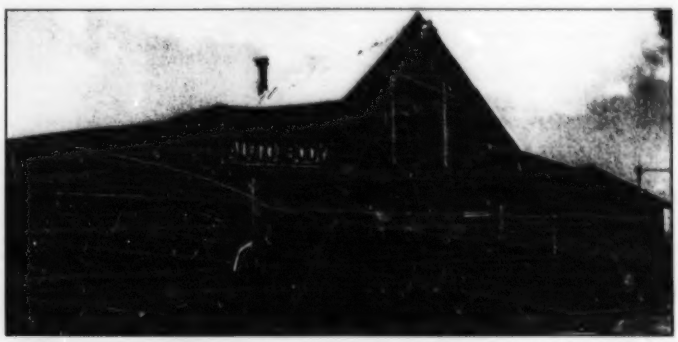
The Koughan Auto Body

Heating an Auto Body Shop with Biomass

Biomass Combustion Systems
Spring 2001

The recent upward trend in oil and gas prices has caused many Canadian business owners to reflect on the finite nature of fossil fuels and to take another look at renewable sources of energy such as solar, wind and biomass. Many are discovering that renewable energy technologies today are well developed and reliable.

This case study features one of several small businesses that have installed a biomass combustion system (BCS).



Dave Koughan and his father Bill stand in front of their auto body shop which is heated by a BCS located at the right of the shop.

Bioenergy is regarded as "green" energy for several reasons. Assuming that biomass resources, such as forests, are managed properly, biomass fuels are infinitely renewable. They have already proven to be economically stable sources of energy over time. Bioenergy is neutral in terms of carbon dioxide (CO_2) emissions. The burning of biomass fuels merely releases the CO_2 that the plants absorbed over their life spans. In contrast, the combustion of fossil fuels releases large quantities of long-stored CO_2, which contributes directly to climate change. Using bioenergy displaces fossil fuels and helps slow the rate of climate change.

Commercial wood heating is common in rural areas across Canada. Between 1980 and 1993, many businesses and institutions in the Atlantic provinces installed automated biomass heating plants to stem rising energy costs. Despite relatively low oil prices in the last decade, many businesses have continued to operate – and often expand – their biomass heating plants. They have achieved significant savings and other benefits from low-cost bioenergy.

Introduction

BCSs are used to heat many types of businesses. A somewhat unusual use is in an auto body shop. Dave Koughan owns an auto body repair business in Donagh, Prince Edward Island, 15 km east of Charlottetown. Because heating oil is so expensive, Dave originally heated the shop only during working hours. But the uneven heat in the shop was not well suited for drying paint on freshly painted automobiles.

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In 1992 Dave expanded the auto body shop to 290 m^2 (3100 sq. ft.). Then he needed a new heating system. "I wanted a cost-effective heating system that would keep the building warm around the clock," says Dave. After considering various options, he elected to install a biomass heating system to heat both the shop and the nearby 110-m^2 (1200 sq. ft.) home of his father, Bill Koughan. Under-floor heat distribution systems were installed in both buildings. The BCS was installed in a new, separate building that measures 9 m x 15 m (30 ft. x 50 ft.).

Technical Data

Dave Koughan's BCS is a 130-kW wood-chip burner that was designed in Prince Edward Island and partially built in southern Ontario. It has four major components: a 2-m^3 fuel (or day) bin; a 130-kW combustion cell (or chamber); a boiler; and a stack (or chimney).

The fuel bin has an agitator – a central rotating shaft with a number of angled paddles. They stir the fuel to prevent bridging and to ensure that it flows continuously to a small, 13-cm (about 5 in.) screw auger at the bottom of the bin. The auger meters the wood chips into the second component of the system, the combustion cell.

The combustion cell has a steel bar grate upon which the fuel (fed by the auger) spreads out, dries and burns. The grate is surrounded by high-temperature firebrick that becomes red hot under heavy firing. A variable speed fan provides two separate streams of pre-heated, primary (or under-fire) and secondary (or over-fire) combustion air to the fire. The combustion cell sends a jet of flame through a firebrick-lined tunnel into the third component of the system, the water tube boiler.

Dave Koughan's tractor-powered chipper.

The boiler is a heat exchanger that extracts heat from the hot gases and transfers it to water, which is circulated through the boiler. The cooled gases then pass up the stack, which is the fourth major component in the system.

The hot water from the boiler is then distributed to the various heat loads (or zones) in the system via insulated underground piping. The temperature in each zone is regulated by a separate thermostat, which turns the circulation pumps on and off to maintain the desired temperature.

The net heat output of the BCS is controlled by an Aquastat – a temperature-control mechanism in the boiler that regulates the quantities of fuel fed to the combustion

cell. The BCS operates in either the high-fire mode, when the Aquastat calls for heat, or the hold-fire (or idle) mode, when the boiler reaches the desired temperature.

The burning of fuel in an automated biomass system occurs under ideal conditions – very high temperatures in the cell, with controlled under-fire and over-fire air. This results in high combustion efficiency and low emissions with very little smoke or airborne particulates being produced.

System Cost

Dave Koughan's bioenergy system cost about $50,000 in 1992. This covered the burner and boiler, the heating plant building, the entire heat distribution system and a used skid-steer loader (which cost $3,500) to fill the day bin. A separate fuel-storage building was constructed near the heating plant in 1994.

Biomass Fuel Supply

In the early years, the Koughans hired a farmer with a tractor-powered chipper to chip 32–48 t (20–30 cords) of wood that they harvested from their wood lot of 47 ha (115 acres). They also bought a few loads of sawdust to supplement their chips.

The Koughan family places a high value on being self-sufficient in the heating of both their business and the home. "I'm pretty pleased with the way things have worked out with the wood-chip system," says Dave Koughan.

In 1996 they bought a used tractor-powered chipper for $5,800. (A new chipper of the same capacity costs about $15,000.) This gave the Koughans control over the entire fuel production process.

The fuel is prepared for storage.

Although Dave's father is retired, he is still very active managing the woodland on the farm. Each year, he and some hired help harvest a block of woodland and produce about 75 t (50 cords) of sawlogs for sale and a similar volume of chipping wood.

The Koughans usually chip their fuel supply for the winter in September. It takes them about 16 hours to chip about 75 t (50 cords) of wood. The chipping wood consists mainly of tops from the sawlogs as well as trees that are not marketable. All of the wood is cut to eight-foot lengths. They transport the wood on two small trailers and pile it beside the fuel storage building. When they chip the wood, the chipper blows the chips directly into the building through several doors or hatches that match the height of the chipper spout. This way, fuel handling is minimized.

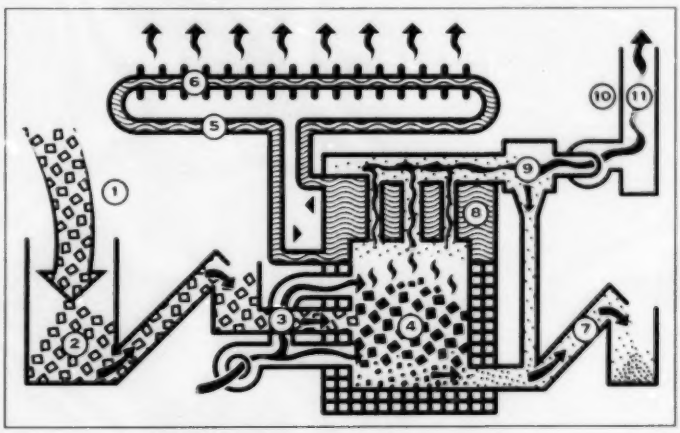
The Koughans also buy the odd truckload of birch or poplar if they are short of chipping wood and if the price is right. Birch or poplar are low-value woods on Prince Edward Island and make excellent wood chips.

Mode of Operation and Maintenance

Bill Koughan is the principal operator of the BCS. He uses the skid-steer loader to fill the day bin. The bin is usually filled in the morning and topped up at the end of the working day during very cold weather.

The Koughans scrape the ash from the combustion cell grate daily and clean out the ash pan below the grate once a week. Fly ash is removed from the boiler about once a month.

Repairs on their BCS have been relatively minor, consisting of items that normally wear, such as drive belts, an auger motor and electrical switches.



Biomass Combustion System -- General Layout
1. Fuel Delivery
2. Fuel Storage
3. Automatic Feed
4. Combustor Unit
5. Water Piping
6. Radiators
7. Ash Disposal
8. Heat Exchanger
9. Particulate Removal
10. Stack
11. Exhaust Gases

Operating Period

The Koughans operate their biomass system year-round. In the winter, it provides low-cost heat and hot water for both the auto body shop and Bill's house. Dave Koughan keeps the BCS running at a low level during the summer to produce hot water for washing cars for the business and domestic hot water for the house.

System Performance

Both Dave Koughan and his father are satisfied with the performance of their biomass system. It provides them with a high degree of convenience and has proved reliable.

Payback and Annual Savings

Dave believes that his biomass system paid for itself in six or seven years. The cost of the chipper probably added an extra year to the payback. "I consider that the payback was reasonable," says Dave. When he installed the wood-chip system, he estimated that it would have cost about $5,500 to heat the expanded auto body shop for the winter with heating oil. But he acknowledges that the cost would now be considerably higher.

Dave calculates that it presently costs about $2,000 per year for biomass heat for the shop and his father's house. This includes both the labour and the diesel fuel involved in producing the wood chips. The cost is somewhat offset by the money they make on about 75 t (50 cords) of sawlogs that they sell from their wood lot each year. Thus, the annual savings produced by the Koughan's biomass system range from $3,500 to $6,000 per year.

Principal Benefits to Koughan's Business

Dave sees low-cost, 24-hour heat in his auto body shop as the main benefit of the BCS. He also likes having the heating plant in a separate building. "It's very safe for an auto body shop," said Dave. "The underfloor heating is also very good, compared to hot-air oil furnaces that blow dust and fumes around the shop."

Dave also parks freshly painted vehicles in the warm heating plant to dry. This frees up shop space for other tasks.

Lessons Learned

The Koughan's installation of a series of chipping hatches on the side of the fuel-storage building is a convenient way to fill the building with wood chips. They start at one end of the building and use the chipper to blow the chips in through the nearest hatch or door. As the first portion of the bin fills up, they move the chipper to the next hatch. This approach allows the storage area to be used to full capacity, without them having to spend time piling the chips with a front-end loader on a tractor. Minimizing the handling of materials is the key to the efficient operation of a bioenergy system.

Future Plans

The Koughan family places a high value on being self-sufficient in the heating of both their business and the home. "I'm pretty pleased with the way things have worked out with the wood-chip system," says Dave Koughan. "And the way things look with oil at the moment, I think that I will be burning wood chips for quite a while." With their bioenergy system running smoothly, the Koughans are not planning any major changes in the foreseeable future.

The burning of fuel in an automated biomass system occurs under ideal conditions – very high temperatures in the cell, with controlled under-fire and over-fire air.

Developing the Canadian Market for BCSs

Natural Resources Canada's (NRCan's) Renewable Energy Deployment Initiative (REDI) promotes investments in renewable energy technologies. These include biomass combustion systems that produce space heat and water heat for businesses.

REDI for Business will refund 25 percent of the purchase and installation costs of a qualifying BCS (i.e. one that is high-efficiency with low emissions) for a business, to a maximum of $80,000. The program is in effect until March 2004. REDI serves to stimulate market demand for renewable energy systems and ensure that industry infrastructures are developed to meet consumer demand.

A buyers' guide to small commercial biomass combustion systems is available from NRCan. For more information, contact the following:

Natural Resources Canada
Renewable Energy Deployment Initiative
580 Booth Street, 18th Floor
Ottawa ON K1A 0E4
Tel.: 1 877 722-6600 (toll-free)
Fax: (613) 943-1590
E-mail: redi.penser@nrcan.gc.ca
Web site: http://www.nrcan.gc.ca/redi

Find out more about how you can benefit from biomass combustion systems or other types of renewable energy technologies by visiting NRCan's Canadian Renewable Energy Network (CanREN) Web site at http://www.canren.gc.ca

GLOSSARY

Aquastat – A temperature-control mechanism that maintains the boiler temperature within a preset range by regulating the quantity of fuel fed to the combustion cell and hence the amount of heat produced. When the boiler temperature drops below the low-limit setting, the Aquastat signals the BCS to operate in high-fire mode. In this mode, the combustion air fan runs continuously, and the feed auger delivers large quantities of fuel to the combustion cell at frequent intervals (e.g. 10 out of every 20 seconds). When the boiler temperature rises to the upper-limit setting, the Aquastat signals the BCS to switch to the hold-fire (or idle) mode. In this mode, the combustion air fan is shut off, and the feed auger delivers only small quantities of fuel to the combustion cell at relatively long intervals (e.g. 5 out of every 100 seconds). It provides only enough fuel to maintain the fire.

BCS – An abbreviation for biomass combustion system.

Bridging – Bridging refers to the tendency of some small-particle, biomass fuels to lock together in an arch configuration above a fuel feed mechanism (such as a screw auger or a day-bin agitator). When this happens, the fuel above the bridging configuration ceases to flow, the BCS is starved for fuel and the production of heat is curtailed.

Cord – A traditional North American unit for measuring the volume of wood. A cord represents a pile of neatly stacked wood that measures 1.2 m x 1.2 m x 2.4 m (4 ft. x 4 ft. x 8 ft.). The pile volume, including air spaces, is 3.6 m^3 (128 cu. ft.), but the actual solid wood volume is about 2.3 m^3 (80 cu. ft.). A cord of softwood weighs about 1.6 t. A cord of green softwood (chipped) can displace about 340 L of heating oil.

Moisture content – The moisture content in wood or other biomass fuels is most commonly expressed on a "wet basis." Moisture content on a wet basis (or MCWB) refers to the proportion of the total weight of a given quantity of wood that is actually water. For example, if green wood has a moisture content of 45 percent MCWB, then 45 percent of the total weight is water and 55 percent of the total weight is wood.

Units of measure – Wood chips and other particulate wood-waste materials are sold in a variety of measurement units. Wood fuels may be sold by weight (e.g. by the tonne) either with or without a calculation of the moisture content of the wood. Wood fuels may also be sold by volume (e.g. in cubic metres or cubic yards) or simply by a fixed amount for a truckload of a stated volume. The haul distance from the source (e.g. a sawmill) is also commonly factored into the delivered price of biomass fuels.

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